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Assessment of Nutrient Status of Soils in Mahanandi Mandal, Kurnool district of Andhra Pradesh

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ABSTRACT
The nutrient status of ten profile samples of Mahanandi mandal, Kurnool district was evaluated for physico-chemical properties, electro-chemical properties, macronutrients ,Exchangeable bases and cationic micro nutrients (Fe , Mn, Cu and Zn). The pedons were neutral to moderately alkaline in reaction, non-saline and low to medium in organic carbon content. All these pedons were low to high in CEC and CaCO3 status. The exchange complex was dominated by Ca^{2+} followed by $Mg2^{+,}$ Na^{+} and K^{+}. Based on the soil test values of N, P and K, soil samples were classified into three categories i.e., low, medium and high, and micronutrients classified as deficient and sufficient. Nutrient analysis of the Mahanandi mandal revealed that the soils were low (28.00 mg $kg^{-1)}$ to medium (243.6 mg kg^{-1}) in nitrogen, low (1.21 mg kg^{-1}) to high 29.33 (mg kg^{-1}) in phosphorus and high (502.4 mg kg^{-1}) in potassium. As far as DTPA extractable micronutrients are concerned, the available iron, zinc, copper and manganese were deficient to sufficient.
Key words: *Nutrient status, physic-chemical properties, Electro-chemical properties, macronutrients and micronutrients*

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INTRODUCTION

Soil plays a major role in determining the sustainable productivity of an agro ecosystem. The sustainable productivity of a soil mainly depends upon its ability to supply essential nutrients to the crop. The availability of macronutrients & micronutrients in soil is dependent on the parent material, pedogenic process and soil management which may promote, in some cases a reduction of cationic nutrients content. Reduction in native levels of nutrients in soils due to continuous shipping away of nutrients without replenishment has been a cause of concern for all the stakeholders. It is well known that optimum plant growth and crop yields depend upon plant available nutrients to the crop not on their total concentration. For sustainability of the present agricultural system and for management of our finite soil resources, knowledge of the soils and their fertility status is important for making area specific recommendations [7]. It is therefore essential that nutrient supplying capacity of soil be continuously monitored to ensure and improve sustainability of agriculture. Hence an investigation has planned to evaluate the nutrient status of soils in Mahanandi Mandal, Kurnool district of Andhra Pradesh.

MATERIAL AND METHODS

Ten pedons were collected from Mahanandi Mandal, Kurnool district of Andhra Pradesh. The locations of pedons were given in fig 1. Horizon wise soil samples collected were air dried, ground with wooden hammer and passed through 2 mm sieve and preserved in polyethylene bags for laboratory analysis. The samples were analyzed for chemical properties viz pH ,EC, OC, CEC,$CaCO_3$,available N ,P, K and Exchangeable cations were determined as per the procedures outlined by Jackson [4]. The available nitrogen was estimated by the alkaline potassium permanganate method as described by Subbiah and Asija [16]. Available phosphorus content of soils was extracted by using Olsen's extractant as described by Olsen *et al*. [9] using spectrophotometer at 660 nm wavelength. Available potassium in the soils was extracted by employing neutral normal ammonium acetate and determined by aspirating the extract into the flame photometer. Available sulphur in the soil samples was extracted with 0.15 per cent $CaCl_2.2H_2O$ [18] and estimated by turbidimetric method [1]. The cationic micro nutrients were extracted by using DTPA extractant solution of pH 7.3 [8] and the extract was aspirated to atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Soil physico- chemical properties

The results of physico-chemical properties are depicted in Table 1. The pH values of 1:2.5 soil water suspension ranged from 7.31 to 8.32 indicating neutral to moderately alkaline reaction. The variation in pH was attributed to the nature of the parent material, leaching, presence of calcium carbonate and exchangeable sodium. Similar reports were observed by Sekhar *et al.* [14] in central and eastern parts of Prakasam district.

The electrical conductivity in soil water extract of different pedons ranged from 0.19 to 1.00 dSm^{-1}. Electrical conductivity values of all pedons indicated non-saline nature of the soil. The low electrical conductivity may be due to free drainage conditions which favoured the removal of released bases by percolation and drainage water. Devi *et al*. [2] reported similar low electrical conductivity values indicating the non-saline character in the sugarcane growing soils of Chittoor district in Andhra Pradesh.

The organic carbon content in different horizons of pedons varied from 0.02 to 0.75 per cent indicating that organic carbon status was low to medium. The low organic carbon content in these soils might be attributed to the prevalence of tropical condition, where the degradation of organic matter occurs at a faster rate coupled with low vegetation cover, there by leaving less organic carbon in the soils. Similar observations were also made by Sireesha and Naidu [15] in soils of Banaganepalle mandal in Kurnool district.

The calcium carbonate content ranged from 1.00 to 19.00 per cent. The free $CaCO_3$ was observed in all the soils. It could be due to ustic soil moisture regime of the area, which was quite congenial for carbonate formation. The highest CaCO3 content was noticed in the lower horizons of pedons 6 and 7. This might be due to high clay content which led to impeded leaching, consequently accumulation of CaCO3 in the lower horizon. Khanday *et al.* [5] found similar findings in soils of Srinagar district in Kashmir.

Electro-chemical properties

The exchangeable bases in all the pedons were in the order of $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$ on the exchange complex (Table 1). From the distribution of $Ca^{2+}$and Mg^{2+}, it was evident that Ca^{2+} showed the strongest relationship with all the species, comparing these ions it was clear that Mg^{2+} was present in low amounts than Ca^{2+} because of its higher mobility, earlier removal than the later. The higher exchangeable Ca in the surface soil may be due to redistribution of calcium by tree species [10].The CEC values varied from 4.31 to 52.11 cmol (p+) kg^{-1} soil. Relatively low CEC may be due to dominance of clay minerals with low CEC and presence of hydrous oxides of iron and aluminium [6].

Macro nutrient status

The data presented in table 2 regarding the macro nutrient status revealed that the available nitrogen ranged in between 28.00 and 243.6 mg kg^{-1} soil and these soils were low to medium in available nitrogen. The low available nitrogen in the soils may be due to semi-arid climate of the area which might have favored rapid oxidation and lesser accumulation of organic matter, releasing more NO_3-N which could have been lost by leaching [3].

The available phosphorus varied from 1.21 to 29.33 mg kg^{-1} soil and these soils were low to high in available phosphorus. The lower phosphorus content could be attributed to the fixation of released phosphorus by clay minerals and oxides of iron and aluminium and higher available phosphorus in the surface horizons due to the confinement of crop cultivation to the rhizosphere and supplemention of depleted phosphorus through external sources *i.e.* fertilizers [17].

The available potassium in different pedons varied from 66.45 to 502.4 mg kg^{-1} soil and these soils were high in available potassium. The higher potassium content could be attributed to more intense weathering, release of labile K from organic residues, application of K fertilizers and upward translocation of potassium from lower depths along with capillary raise of ground water. Similar results were reported by Reddy and Naidu [13] in soils of Chennur mandal of Kadapa district in Andhra Pradesh.

The available sulphur content varied from 1.34 to 79.15 mg kg^{-1} soil and these soils were deficient to sufficient in available sulphur content. Higher sulphur in surface layers than sub-surface layers, could be due to higher amount of organic matter in surface layers than in deeper layers.

Micro nutrient status

The available zinc varied from 0.02 to 4.97 mg kg^{-1} soil (table 2). All the pedons were deficient to sufficient in zinc, considering 0.6 mg kg^{-1} soil as critical level for available zinc. The low available zinc was possibly due to high soil pH values which might have resulted in the formation of insoluble compounds of zinc or insoluble calcium zincate [12].

The available copper content varied from 0.01 to 0.94 mg kg^{-1} soil. All pedons exhibited an irregular trend with depth. All the pedons were found to be deficient to sufficient in available copper, as per critical limit of 0.2 mg kg^{-1} soil. The higher concentration of copper in the surface horizon might be due to higher

biological activity and the chelating of organic compounds, released during the decomposition of organic matter left after harvesting of crop.

The available iron content ranged from 0.46 to 22.56 mg kg^{-1}soil. According to the critical limit (4.5 mg kg^{-1} soil) the soils were deficient to sufficient in available iron content. Surface horizons had higher concentration of DTPA-extractable Fe due to higher organic carbon [11].

Available manganese content varied between 0.27 and 30.80 mg kg^{-1} .The available manganese content was deficient to sufficient as per critical limit of 1.0 mg kg^{-1} soil. The deficiency of manganese may be due to intensive cropping with high yielding varieties and use of complex fertilizers.

Table 1. Physico–chemical and Electro-chemical properties of the soil

Pedon No. &Horizon	Depth (m)	Physico–chemical properties of soils					Electro-chemical properties of the soil				
		OC %	$CaCO_3$ (%)	pH 1:2.5		EC (dSm^{-1})	CEC (cmol (p+) kg^{-1})	Ca^{2+}	Mg^{2+}	Na^{+}	K
				H_2O	1N KCL						
Pedon 1											
Ap	0.00 – 0.25	0.70	2.00	8.30	7.21	0.83	28.23	19.86	0.25	0.63	1.28
2Bw1	0.25 – 0.52	0.45	1.00	7.71	7.08	0.85	41.63	29.33	2.50	1.41	0.48
2Bw2	0.52 – 0.67	0.60	2.50	7.72	6.75	0.90	49.29	34.79	8.50	1.98	0.44
2Bw3	0.67 – 1.00	0.56	1.50	7.71	6.60	1.00	45.12	33.12	5.00	1.82	0.44
Pedon 2											
Ap	0.00 – 0.22	0.72	1.50	7.60	7.13	0.80	17.92	10.23	0.14	0.92	1.29
2Bw1	0.22 – 0.42	0.56	3.00	7.71	7.00	0.80	47.33	34.00	6.59	1.28	1.28
2Bw2	0.42 – 0.80	0.60	4.00	8.00	6.77	0.52	50.16	35.02	10.23	0.99	1.28
2Bw3	0.80 – 1.10	0.53	3.00	7.80	6.93	0.77	51.25	36.59	10.00	2.11	1.27
Pedon 3											
Ap	0.00 – 0.20	0.71	9.50	8.00	6.80	0.30	8.21	5.14	0.18	0.16	0.15
A1	0.20 – 0.44	0.47	10.50	7.80	7.26	0.27	6.79	4.06	0.14	0.15	0.14
A2	0.44 – 0.69	0.36	12.50	7.90	7.08	0.50	11.89	7.74	0.30	0.19	0.18
Pedon 4											
Ap	0.00 – 0.17	0.62	5.50	7.80	7.01	0.54	24.36	18.06	0.22	0.19	0.45
2Bw1	0.17 – 0.50	0.45	5.50	7.81	6.78	0.47	42.01	28.56	4.01	0.38	1.26
2Bw2	0.50 – 0.79	0.51	8.00	7.81	6.94	0.46	43.58	32.51	4.21	0.39	1.26
2Bw3	7.90 – 1.04	0.45	11.00	7.81	7.13	0.50	44.03	34.52	4.62	0.36	1.26
2Bw4	1.04 – 1.25	0.23	10.00	7.52	7.34	0.53	52.11	38.75	10.80	0.55	1.26
Pedon 5											
Ap	0.00 – 0.24	0.23	1.00	7.42	6.90	0.66	21.64	15.00	0.67	0.16	0.24
A1	0.24 – 0.58	0.15	2.00	7.44	6.71	0.75	18.67	12.58	0.18	0.36	0.25
A2	0.58 – 1.02	0.05	1.00	7.55	6.56	0.59	31.16	21.25	3.20	0.16	0.17
A3	1.02 – 1.32	0.05	2.00	7.74	6.42	0.45	4.31	2.05	0.11	0.11	0.13
A4	1.32 – 1.55	0.03	1.50	7.70	6.36	0.46	40.74	33.29	2.29	0.41	0.55

Table 1. Contd…

Pedon No. &Horizon	Depth (m)	Physico–chemical properties of soils					Electro-chemical properties of the soil				
		OC %	$CaCO_3$ (%)	pH 1:2.5		EC (dSm^{-1})	CEC (cmol(p+) kg^{-1})	Ca^{2+}	Mg^{2+}	Na^{+}	K
				H_2O	1N KCL						
Pedon 6											
Ap	0.00 – 0.16	0.71	1.00	7.90	6.82	0.30	11.13	7.21	0.20	0.23	0.11
2Bw1	0.16 – 0.41	0.20	2.00	8.11	7.10	0.29	25.93	18.35	0.25	0.93	0.27
3Bw2	0.41 – 0.74	0.03	15.00	8.32	7.16	0.32	10.11	6.48	0.22	0.14	0.14
4Bw3	0.74 – 1.14	0.02	5.00	8.27	7.11	0.32	32.09	25.03	0.32	0.39	0.12
5Bw4	1.14 – 1.62	0.30	16.00	8.21	7.30	0.39	43.98	33.00	5.11	0.80	0.37
6Bw5	1.62 – 2.00	0.03	7.00	8.23	6.30	0.43	20.51	14.59	0.28	0.19	0.15
Pedon 7											
Ap	0.00 – 0.22	0.45	1.50	7.71	6.25	0.19	13.93	8.55	0.16	0.22	1.01
Bw1	0.22 – 0.62	0.27	1.00	7.80	5.73	0.22	41.21	33.65	2.69	0.37	0.65
Bw2	0.62 – 0.98	0.26	1.00	7.70	6.27	0.21	42.83	29.45	5.22	0.34	0.92
Bw3	0.98 – 1.28	0.18	9.50	7.75	6.63	0.24	43.26	31. 02	5.30	0.45	1.25
Bw4	1.28 – 1.70	0.12	16.50	8.14	7.02	0.27	49.88	34.99	10.01	0.59	1.26
Bw5	1.70 – 2.00	0.03	19.00	8.27	6.53	0.28	46.21	33.59	6.52	0.27	1.22
Pedon 8											
Ap	0.00 – 0.16	0.75	4.00	7.52	5.73	0.54	27.16	18.32	0.78	0.36	0.91
2A1	0.16 – 0.45	0.45	3.00	7.50	5.95	0.46	29.22	21.29	0.52	0.44	0.92
3Bw1	0.45 – 0.86	0.66	3.00	7.50	6.35	0.47	50.79	36.50	10.23	0.52	1.26
3Bw2	0.86 – 1.29	0.54	3.50	7.62	6.94	0.49	43.06	30.03	4.33	1.04	1.26
3Bw3	1.29 – 1.59	0.30	3.00	8.0	7.24	0.52	48.91	34.81	7.58	1.97	1.28
3Bw4	1.59 – 2.00	0.08	5.00	8.20	5.91	0.57	43.46	32.87	4.35	0.18	1.07
Pedon 9											
Ap	0.00 – 0.20	0.65	1.50	7.41	5.62	0.45	19.27	12.98	0.14	0.16	0.65
Bw1	0.20 – 0.50	0.45	2.00	7.42	5.74	0.46	28.66	20.99	0.64	0.17	0.70
Bw2	0.50 – 0.79	0.38	1.00	7.31	6.34	0.47	30.12	22.01	1.19	0.18	0.70
Bw3	0.79 – 1.09	0.45	9.00	7.50	6.72	0.47	27.72	18.59	1.90	0.29	0.83
Bw4	1.09 – 1.33	0.38	14.00	7.75	6.90	0.49	26.37	16.61	1.74	0.38	0.98
Bw5	1.33 – 1.60	0.08	14.50	7.56	6.51	0.51	25.01	14.95	1.58	0.40	1.21
Pedon 10											
Ap	0.00 – 0.20	0.75	5.00	7.67	6.33	0.58	12.26	7.89	0.10	0.15	0.58
A1	0.20 – 0.50	0.57	2.00	7.62	6.25	0.43	30.23	22.03	0.32	0.45	1.26
Bw1	0.50 – 0.80	0.42	2.50	7.68	6.50	0.49	47.90	33.88	8.55	0.58	1.16
Bw2	0.80 – 1.12	0.30	11.00	7.70	6.69	0.44	48.68	34.42	8.80	0.61	1.26
Bw3	1.12 – 1.41	0.38	10.00	7.82	6.90	0.43	42.99	29.87	4.69	0.49	1.27
Bw4	1.41 – 2.00	0.33	12.00	7.87	7.00	0.50	43.71	32.88	4.30	0.43	1.26

Table 2. Available macronutrient and available micronutrient status (mgkg^{-1}) of the soils

Pedon No. &Horizon	Depth (m)	Available macronutrients (mgkg^{-1})				Available micronutrients(mgkg^{-1})			
		N	P	K	S	Cu	Fe	Mn	Zn
Pedon 1									
Ap	0.00 – 0.25	151.20	5.73	498.00	22.13	0.49	9.08	0.41	0.02
2Bw1	0.25 – 0.52	84.00	7.73	185.30	6.04	0.04	0.46	0.69	0.16
2Bw2	0.52 – 0.67	61.60	5.73	171.00	75.12	0.01	2.67	3.57	0.44
2Bw3	0.67 – 1.00	78.40	9.44	172.35	14.76	0.01	1.85	0.94	0.30
Pedon 2									
Ap	0.00 – 0.22	114.80	11.25	502.40	1.34	0.40	4.00	15.59	0.78
2Bw1	0.22 – 0.42	89.60	18.08	500.45	79.15	0.01	4.22	0.27	0.26
2Bw2	0.42 – 0.80	114.80	7.83	498.55	29.51	0.20	3.89	13.62	0.48
2Bw3	0.80 – 1.10	95.20	15.17	496.80	34.88	0.31	4.39	10.59	0.29
Pedon 3									
Ap	0.00 – 0.20	168.00	15.97	496.20	36.22	0.01	6.27	4.45	0.55
A1	0.20 – 0.44	81.20	29.33	495.60	22.81	0.62	11.85	13.26	4.63
A2	0.44 – 0.69	126.00	16.88	502.00	39.57	0.57	9.08	10.59	3.73
Pedon 4									
Ap	0.00 – 0.17	243.60	12.05	498.20	29.51	0.90	6.76	1.77	1.60
2Bw1	0.17 – 0.50	148.40	23.40	489.70	18.11	0.46	6.87	6.70	0.73
2Bw2	0.50 – 0.79	95.20	11.65	490.80	16.77	0.42	6.38	5.97	1.60
2Bw3	7.90 – 1.04	89.60	8.14	492.30	50.98	0.19	3.12	6.15	1.80
2Bw4	1.04 – 1.25	58.80	10.04	114.15	22.81	0.44	9.30	7.35	1.78
Pedon 5									
Ap	0.00 – 0.24	193.20	24.41	92.00	22.81	0.15	9.80	26.80	4.97
A1	0.24 – 0.58	58.80	8.14	95.55	45.61	0.01	8.14	30.04	2.19
A2	0.58 – 1.02	42.00	18.28	66.45	6.71	0.01	6.32	24.60	1.70
A3	1.02 – 1.32	28.00	20.19	84.20	6.71	0.01	14.06	22.58	1.80
A4	1.32 – 1.55	50.40	11.65	214.30	24.82	0.04	8.42	27.54	2.08

Table 2. Contd..

Pedon No. & Horizon	Depth (m)	Available macronutrients (mgkg^{-1})				Available micronutrients(mgkg^{-1})			
		N	P	K	S	Cu	Fe	Mn	Zn
Pedon 6									
Ap	0.00 – 0.16	84.00	16.67	132.00	26.16	0.36	14.06	30.80	2.09
2Bw1	0.16 – 0.41	75.60	14.06	103.80	17.44	0.14	7.59	24.80	1.79
3Bw2	0.41 – 0.74	42.00	7.53	128.60	32.87	0.01	4.44	16.03	1.65
4Bw3	0.74 – 1.14	72.80	11.55	141.55	4.70	0.01	3.39	12.78	1.69
5Bw4	1.14 – 1.62	42.00	2.91	145.20	15.43	0.01	3.78	10.46	1.73
6Bw5	1.62 – 2.00	58.80	8.84	492.35	16.77	0.01	3.34	9.53	1.41
Pedon 7									
Ap	0.00 – 0.22	196.00	11.25	394.65	10.06	0.34	15.99	28.46	1.91
Bw1	0.22 – 0.62	112.00	23.10	254.70	14.76	0.38	15.66	25.90	1.65
Bw2	0.62 – 0.98	89.60	11.65	357.20	14.09	0.35	12.51	22.40	1.71
Bw3	0.98 – 1.28	89.60	6.93	485.95	4.02	0.94	2.97	3.75	0.20
Bw4	1.28 – 1.70	86.80	20.19	492.10	21.46	0.37	9.91	17.85	1.72
Bw5	1.70 – 2.00	86.80	18.28	475.50	14.09	0.14	5.99	13.93	1.70
Pedon 8									
Ap	0.00 – 0.16	165.20	23.00	355.90	22.13	0.03	5.10	10.97	1.79
2A1	0.16 – 0.45	142.80	9.74	357.35	20.79	0.01	4.33	11.89	1.44
3Bw1	0.45 – 0.86	100.80	8.14	491.40	26.16	0.01	3.39	7.08	1.46
3Bw2	0.86 – 1.29	78.40	9.74	493.25	10.06	0.01	1.68	3.29	1.41
3Bw3	1.29 – 1.59	75.60	8.14	497.85	8.05	0.01	1.02	3.11	1.43

3Bw4	1.59 – 2.00	75.60	16.47	418.65	32.20	0.01	0.57	2.61	1.41
Pedon 9									
Ap	0.00 – 0.20	184.80	8.44	253.85	4.70	0.01	7.54	18.42	1.50
Bw1	0.20 – 0.50	145.60	16.98	272.75	11.40	0.01	5.55	6.84	1.46
Bw2	0.50 – 0.79	103.60	13.36	273.50	16.10	0.03	3.34	8.26	1.44
Bw3	0.79 – 1.09	103.60	10.04	322.80	26.83	0.01	2.23	4.45	1.42
Bw4	1.09 – 1.33	78.40	11.65	382.70	24.15	0.01	1.57	3.88	1.41
Bw5	1.33 – 1.60	67.20	6.33	472.45	25.49	0.01	1.51	4.02	1.44
Pedon 10									
Ap	0.00 – 0.20	215.60	8.84	487.25	22.81	0.26	22.56	14.84	1.62
A1	0.20 – 0.50	165.20	1.51	490.45	12.07	0.01	2.23	6.39	1.36
Bw1	0.50 – 0.80	78.40	5.22	452.45	12.07	0.01	3.01	4.58	1.36
Bw2	0.80 – 1.12	78.40	1.21	490.10	38.23	0.01	3.23	3.26	1.36
Bw3	1.12 – 1.41	67.20	9.74	494.60	13.42	0.01	2.56	2.69	1.39
Bw4	1.41 – 2.00	84.00	5.12	492.40	25.49	0.01	0.69	2.84	1.42

CONCLUSION

Deficiency of macronutrients and micronutrients has become major constraint to productivity and sustainability in many Indian soils. Role of micronutrients in balanced plant nutrition is well established. Micronutrients are very important for maintaining soil health and also in increasing productivity of crops. All the pedons were neutral to moderately alkaline in reaction, non-saline and low to medium in organic carbon content. All these pedons were low to high in $CaCO_3$ status. The exchange complex was dominated by Ca^{2+} followed by Mg^{2+}, Na^{+} and K^{+}. Regarding the fertility status, the soil samples were low to medium in available nitrogen, low to high in available phosphorus and high in available potassium and deficient to sufficient in available sulphur. However, DTPA extractable Fe, Mn, Zn and Cu were deficient to sufficient in status.

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